

What is claimed is:

1 1. A microfluidic system having enhanced optical detection, comprising:
2 a microfluidic device that comprises:
3 a body structure that is planar in a first plane;
4 a first channel segment that is parallel to the first plane;
5 a detection channel segment having a first and a second end, wherein the first
6 end of the detection channel segment is in fluid communication with the first channel segment, the
7 detection channel segment being oriented substantially orthogonally to the first plane; and
8 a detection system in sensory communication with the detection channel
9 segment and oriented to provide a detection path substantially along a longitudinal axis of the
10 detection channel segment.

1 2. The microfluidic system of claim 1, wherein the body structure comprises at
2 least first and second substrate layers bonded together, the first channel segment being defined at an
3 interface of the first and second planar substrates, and wherein the detection channel segment
4 comprises a via disposed through at least one of the first and second planar substrates.

1 3. The microfluidic system of claim 1, further comprising a second channel
2 segment that is in fluid communication with the second end of the detection channel segment.

1 4. The microfluidic system of claim 1, wherein the body structure comprises at
2 least first, second and third planar substrate layers, a first surface of the first substrate being bonded
3 to a first surface of the second substrate, and a first surface of the third substrate being bonded to a
4 second surface of the second substrate, the second surface of the second substrate being opposite to
5 the first surface of the second substrate, the first channel segment being defined at an interface of
6 the first and second planar substrate layers, and the second channel segment being defined at an
7 interface of the second and third planar substrate layers, and wherein the detection channel segment
8 comprises a via disposed through at least the second planar substrate layer.

1 5. The microfluidic system of claim 1, wherein the detection system comprises
2 an absorbance measurement system.

1 6. The microfluidic system of claim 1, wherein the absorbance detection system
2 comprises:
3 a light source;
4 an optical train positioned proximal to the first end of the detection channel segment,
5 wherein the optical train directs light from the light source through the first end of the detection
6 channel segment; and
7 a light detector positioned proximal to the second end of the detection channel
8 segment for detecting an amount of light that passes through the detection channel segment.

1 7. The microfluidic system of claim 1, wherein the detection channel segment
2 has a cross sectional area that is between about 0.1 and 5 times a cross sectional area of at least one
3 of the first and second channel segments.

1 8. The microfluidic system of claim 1, wherein the cross-sectional area of the
2 detection channel segment is from about 0.5 to about 2 times the cross sectional area of at least one
3 of the first and second channel segments.

1 9. The microfluidic system of claim 1, wherein the detection channel segment is
2 from about 10 μm to about 1mm in length.

1 10. The microfluidic system of claim 1, wherein the detection channel segment is
2 from about 50 to about 500 μm in length.

1 11. The microfluidic system of claim 1, wherein the detection channel segment is
2 from about 100 to about 250 μm in length.

1 12. The microfluidic system of claim 1, wherein the detection channel segment
2 comprises a volume that is less than 100 nl.

1 13. The microfluidic system of claim 1, wherein the detection channel segment
2 comprises a volume that is less than 10 nl.

1 14. The microfluidic system of claim 1, wherein the detection channel segment
2 comprises a volume that is less than 1 nl.

1 15. A microfluidic system for enhanced optical detection, comprising:
2 a body structure that is planar in a first plane;
3 a first detection channel segment being disposed in a second plane that is
4 substantially orthogonal to the first plane; and
5 an optical detector positioned to be in sensory communication with the first detection
6 channel segment, the detector being oriented to direct light into and receive light from the detection
7 channel segment along a detection path that is substantially parallel to the second plane.

1 16. The microfluidic system of claim 0, wherein the first and second planes are
2 parallel.

1 17. The microfluidic system of claim 0, further comprising at least a second
2 channel segment in fluid communication with the detection channel segment.

1 18. The microfluidic system of claim 0, wherein the second channel segment is
2 disposed to be positioned in a third plane that is different from the first plane.

1 19. The microfluidic system of claim 0, wherein the first and second channel
2 segments are disposed in a planar body structure, the first and second planes being perpendicular to
3 a plane of the planar body structure and the third plane being parallel to the plane of the body
4 structure.

1 20. The microfluidic system of claim 0, wherein the planar body structure
2 comprises at least first, second and third substrate layers, wherein the first substrate layer is
3 sandwiched between the second and third substrate layers, the first channel segment being disposed
4 as an aperture through the first substrate layer, and the second channel segment being disposed at
5 the interface of the first and second substrate layers.

1 21. A microfluidic system comprising:

2 a planar body structure comprising a first channel and a detection channel segment
3 disposed therein, the first channel being disposed in a major plane of the planar body structure, and
4 the detection channel being disposed substantially orthogonally to the major plane of the body
5 structure; and

6 an optical detector in sensory communication with the detection channel segment,
7 the optical detector being positioned to direct and/or receive optical energy in a direction parallel to
8 the detection channel segment through an end of the detection channel segment.

1 22. An analytical system, comprising

2 a first fluid conduit disposed in a body structure, the first fluid conduit having first
3 and second ends, and a longitudinal axis;

4 a light source proximal to the first end of the first fluid conduit, and positioned to
5 direct light through the first fluid conduit in a path substantially parallel to the longitudinal axis;

6 at least a first spatial filter attached to the body structure and positioned between the
7 first end of the fluid conduit and the light source; and

8 an optical detector positioned to receive optical signals from the first fluid conduit.

1 23. The system of claim 22, wherein the optical detector is positioned proximal
2 to the second end of the first fluid conduit and directed to receive light from the light source that
3 passes through the first fluid conduit.

4 24. The system of claim 23, further comprising a second spatial filter positioned
5 between the second end of the first fluid conduit and the optical detector.

1 25. The system of claim 22, wherein the at least first spatial filter is provided on
2 an exterior surface of the body structure.

1 26. The system of claim 22, wherein the at least first spatial filter is disposed in
2 an interior region of the body structure.

1 27. An analytical system, comprising

2 a first fluid conduit disposed in a body structure, the first fluid conduit having first
3 and second ends, and a longitudinal axis;

4 a light source proximal to the first end of the first fluid conduit, and positioned to
5 direct light through the first fluid conduit in a path substantially parallel to the longitudinal axis;

6 at least a first spatial filter attached to the body structure and positioned proximal to
7 the first end of the fluid conduit such that light from the light source passes through the spatial filter
8 before entering into the first fluid conduit; and

9 an optical detector positioned to receive optical signals from the first fluid conduit.

1 28. The system of claim 27, wherein the optical detector is positioned proximal
2 to the second end of the first fluid conduit and directed to receive light from the light source that
3 passes through the first fluid conduit.

1 29. The system of claim 28, further comprising a second spatial filter positioned
2 proximal to the second end of the first fluid conduit and the optical detector, such that light from the
3 first fluid conduit that contacts the detector passes through the second spatial filter.

1 30. The system of claim 27, wherein the at least first spatial filter is provided on
2 an exterior surface of the body structure.

1 31. The system of claim 27, wherein the at least first spatial filter is disposed in
2 an interior region of the body structure.

1 32. A method of performing an analytical operation in a microscale channel,
2 comprising:

3 providing a planar microfluidic device having a first detection channel segment that
4 is substantially orthogonal to a major plane of the planar microfluidic device;

5 introducing a sample material into the first detection channel segment, the first
6 sample material having a concentration of an optically detectable material disposed therein;

7 directing an optical detection path through the sample material in the detection
8 channel segment at an angle that is substantially parallel to a longitudinal axis of the first detection
9 channel segment; and

10 detecting an optical signal from the sample material.

1 33. The method of claim 32, wherein the steps of directing and detecting
2 comprise directing a light signal through the sample material and detecting an amount of light
3 transmitted by the sample material.

1 34. The method of claim 32 further comprising the step of determining an
2 amount of the light signal absorbed by the sample material from the amount of light signal
3 transmitted by the sample material.

1 35. The method of claim 32, further comprising providing at least a second
2 channel disposed in the planar microfluidic device, the second channel being parallel to the major
3 plane of the microfluidic device, and in fluid communication with the first detection channel
4 segment.

1 36. The method of claim 32, wherein the first channel is also fluidly connected to
2 a sampling capillary that is attached to and extends from the microfluidic device, and wherein the
3 step of introducing the first sample material into the detection channel segment comprises drawing a
4 sample material from a source of sample material into the sampling capillary and transporting the
5 sample material into the second channel segment and into the detection channel segment.

1 37. A method of enhancing sensitivity of optical detection in a microscale
2 channel, comprising:
3 introducing a sample fluid having a concentration of optically detectable material
4 disposed therein into a detection channel segment having a first length;
5 directing light along substantially the entire first length from at least one end of the
6 detection channel segment; and
7 detecting the optically detectable material from at least one end of the detection
8 channel segment.